

SLB A1

WHAT IS CLAIMED IS:

1. A piezoelectric element comprising:
a plurality of piezoelectric layers comprising a piezoelectric material comprising Sr, Bi, Ti, and O;
at least three vibration electrodes opposing each
5 other, each disposed among the piezoelectric layers; and
an energy-confining region formed in a region in
which the vibration electrodes overlap and exciting an n-
th order longitudinal thickness vibration;

10 wherein the maximum length L of a secant between two
intersections on the periphery of the energy-confining
region and the distance t between the topmost vibration
electrode and the bottommost vibration electrode satisfy
the ratio $nL/t < 10$, wherein n is greater than 1.

2. A piezoelectric element according to claim 1,
wherein the piezoelectric material comprises $\text{SrBi}_4\text{Ti}_4\text{O}_{15}$.

3. A piezoelectric element comprising:
a plurality of piezoelectric layers comprising a piezoelectric material comprising Ca, Bi, Ti, and O;
at least three vibration electrodes opposing each
5 other, each disposed among the piezoelectric layers; and
an energy-confining region formed in a region in
which the vibration electrodes overlap and exciting an n-
th order longitudinal thickness vibration;
wherein the maximum length L of a secant between two
10 intersections on the periphery of the energy-confining

Claim 2
cont

region and the distance t between the topmost vibration electrode and the bottommost vibration electrode satisfy the ratio $nL/t < 9$, wherein n is an integer greater than 1.

4. A piezoelectric element according to claim 3, wherein the piezoelectric material comprises $\text{CaBi}_4\text{Ti}_4\text{O}_{15}$.

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5. A piezoelectric element comprising:

a plurality of piezoelectric layers comprising a piezoelectric material comprising Sr, Bi, Nb, and O; at least three vibration electrodes opposing each other, each disposed among the piezoelectric layers; and an energy-confining region formed in a region in which the vibration electrodes overlap and exciting an n -th order longitudinal thickness vibration;

10 wherein the maximum length L of a secant between two intersections on the periphery of the energy-confining region and the distance t between the topmost vibration electrode and the bottommost vibration electrode satisfy the ratio $nL/t < 10$, wherein n is an integer greater than 1.

6. A piezoelectric element according to claim 5, wherein the piezoelectric material comprises $\text{SrBi}_2\text{Nb}_2\text{O}_9$.

7. A piezoelectric element according to claim 1, wherein the topmost vibration electrode and the

bottommost vibration electrode are formed on the outer surfaces of the piezoelectric layers.

8. A piezoelectric element according to claim 2, wherein the topmost vibration electrode and the bottommost vibration electrode are formed on the outer surfaces of the piezoelectric layers.

9. A piezoelectric element according to claim 3, wherein the topmost vibration electrode and the bottommost vibration electrode are formed on the outer surfaces of the piezoelectric layers.

10. A piezoelectric element according to claim 4, wherein the topmost vibration electrode and the bottommost vibration electrode are formed on the outer surfaces of the piezoelectric layers.

11. A piezoelectric element according to claim 5, wherein the topmost vibration electrode and the bottommost vibration electrode are formed on the outer surfaces of the piezoelectric layers.